Introduction

In Japan, the Cancer Control Act was implemented in 2007 in response to patients' urgent petitions to the government. This law strongly advocates the promotion of radiotherapy (RT) and an increase in the number of radiation oncologists (ROs) and medical physicists. At the same time, the Ministry of Health, Labour and Welfare began the accreditation of "designated cancer care hospitals" with the aim of correcting regional differences in the quality of cancer care and strengthening cooperation among regional cancer care hospitals. The Japanese Society of Therapeutic Radiology and Oncology (JASTRO) has conducted national structure surveys of RT facilities in Japan every 2 years since 1990.[1] The structure of radiation oncology in Japan has improved in terms of equipment and functions in accordance with the increasing number of cancer patients who require RT. Public awareness of the importance of RT is gradually expanding due to the above law. We introduced Patterns of Care Study (PCS) in Japan in 1996; these studies have been carried out every 4 years and have disclosed significant differences in the quality of RT according to the types of facilities and their caseloads.

In the present study, the structure of radiation oncology in designated cancer care hospitals in Japan was investigated in terms of equipment, personnel, patient load, and geographic distribution, and compared with these features of other RT facilities in Japan.

Materials and methods

JASTRO carried out a national structure survey of radiation oncology in 2005, in the form of a questionnaire, between March 2006 and February 2007.[2,3] The questionnaire consisted of questions about the number of treatment machines and modality by type, the number of personnel by job category, and the number of patients by type and the disease site. The response rate was 712 of 735 (96.9%) from all actual RT facilities in Japan.

The number of facilities certified by the Ministry of Health, Labour and Welfare as designated cancer care hospitals by the end of fiscal 2007 was 351. Of the total 351 facilities, 47 were designated prefectural cancer care hospitals and 304 were designated regional cancer care hospitals. Three hundred and fifty-three facilities, including the National Cancer Center Hospital and the National Cancer Center Hospital East were included in this group as designated cancer care hospitals. Seven facilities did not return the survey data, and 20 facilities did not have departments of RT at that point in the survey. The structures of 326 designated cancer care hospitals and the other 386 RT facilities were then analyzed. SAS 8.02[4] (SAS Institute, Cary, NC, USA) was used for the statistical analysis. The statistical significance was tested by means of a χ^2 test, Students' t-test, or analysis of variance (ANOVA).

The Japanese Blue Book guidelines[5] were used as the standard of comparison with the results of this study. These guidelines show the guidelines for the structure of radiation oncology in Japan based on PCS data.[5,6] The standard guidelines for annual patient load/external beam equipment were set at 250–300 (warning level 400); those for annual patient load /full-time equivalent (FTE) radiation oncologist (RO) were set at 200 (warning level 300), and those for annual patient load /FTE RT technologists at 120 (warning level 200).[5,6]

Results

Current situation of radiation oncology in designated cancer care hospitals and the other RT facilities in Japan

Table 1 shows the numbers of new patients and total numbers of patients (new plus repeats) requiring RT in 2005 at the total number of surveyed designated cancer care hospitals and other RT facilities in Japan ($n = 712$). Designated cancer care hospitals accounted for 45.3% (333/735) of all the RT facilities in Japan. The numbers of new patients and total numbers of patients in all the RT facilities in Japan were estimated at approximately 162 000 (156 318*735/712) and 198 000 (191 173*735/712), respectively (see Table 1 footnote). In designated cancer care hospitals, the corresponding numbers of patients were approximately 99 000 (96 558*333/326) and 121 000 (118 548*333/326), respectively (see Table 1 footnote). The number of patients in designated cancer care hospitals accounted for 61.1% of the number of patients in all RT facilities, for both new patients and the total number of patients (99 000/162 000 and 121 000/198 000; see Table 1 footnote). The average numbers of new patients/facility were 296.2 for designated cancer care hospitals and 154.8 for the other RT facilities, respectively ($P < 0.0001$). For the average numbers of total

Table 1. The numbers of new patients and total patients (new plus repeat) requiring radiotherapy (RT) in designated cancer care hospitals and the other RT facilities

	Designated cancer care hospitals	Other RT facilities	P value	Total
Facilities	326	386		712
New patients	96558[a]	59760		156318[b]
Average no. new patients/facility	296.2	154.8	<0.0001	219.5
Total patients (new + repeat)	118548[a]	72625		191173[b]
Average no. total patients/facility	363.6	188.1	<0.0001	268.5

[a]The number of designated cancer care hospitals with RT was 333, and the number of new patients in designated cancer care hospitals was estimated at approximately 99000 (96558*333/326); the corresponding number of total patients (new plus repeat) was 121000 (118548*333/326)
[b]The number of RT facilities was 735 in 2005, and the number of new patients was estimated at approximately 162000 (156318*735/712); the corresponding number of total patients (new plus repeat) was 198000 (191173*735/712)

patients/facility, the corresponding data were 363.6 and 188.1, respectively ($P < 0.0001$).

Table 2 shows the equipment patterns, staffing patterns, and patient loads in designated prefectural cancer care hospitals and designated regional cancer care hospitals. There were significant differences in the average number of linear accelerators (Linacs)/facility, the ownership of the intensity-modulated RT (IMRT) function of the Linac, the average number of patients/facility, the average number of patients/Linac, the number of ^{192}Ir remote-controlled afterloading systems (RALSs) ($P < 0.0001$), and the number of computed tomography (CT) simulators in the two types of facilities ($P = 0.0015$). The IMRT function does not necessarily mean its actual use in 2005, but its availability as equipment. The average numbers of FTE ROs/facility were 3.1 for designated prefectural cancer care hospitals and 1.2 for designated regional cancer care hospitals ($P < 0.0001$). The average numbers of JASTRO-certified physicians/facility were 2.1 and 0.7 ($P < 0.0001$).

Facility and equipment patterns and patient load/Linac in designated cancer care hospitals and the other RT facilities

Table 3 shows the RT equipment patterns and related functions in the designated cancer care hospitals and the other RT facilities. In the designated cancer care hospitals, 397 Linacs, 7 telecobalt machines, 17 Gamma Knife machines, 46 ^{60}Co RALSs, and 91 ^{192}Ir RALSs were actually used. In the other RT facilities, the corresponding data were 368, 4, 31, 18, and 28, respectively. The ownership of equipment in designated cancer care hospitals, excluding telecobalt machines and Gamma Knife machines, was significantly higher than that in the other RT facilities (Linac, $P = 0.0002$; other equipment, $P < 0.0001$). In designated cancer care hospitals, the Linac system used dual-energy function in 291 systems (73.1%), three-dimensional conformal RT function (3DCRT) in 268 (67.5%), and IMRT function in 119 (30.0%). In the other RT facilities, the corresponding data

Table 2. Equipment patterns, staffing patterns, and patient loads in designated prefectural cancer care hospitals and designated regional cancer care hospitals

	Designated prefectural cancer care hospitals (n = 49)		Designated regional cancer care hospitals (n = 277)		P value
	n	%	n	%	
Linac	87	100.0[a]	310	95.7[a]	0.1377
With IMRT function	46	52.9[b]	73	23.5[b]	<0.0001
No. Linacs/facility	1.8		1.1		<0.0001
Annual no. patients/facility	722.3		300.2		<0.0001
Annual no. patients/Linac	406.8[c]		257.0[c]		<0.0001
^{192}Ir RALS (actual use)	37	75.5	54	8.6	<0.0001
No. of CT simulators	47	83.7[c]	170	59.9[c]	0.0015
Average no. of FTE ROs/facility	3.1		1.2		<0.0001
Average no. of JASTRO-certified ROs/facility	2.1		0.7		<0.0001

Linac, Linear accelerator; IMRT, intensity-modulated RT; RALS, remote-controlled afterloading system; CT, computed tomography; FTE, full-time equivalent (40 h/week only for RT practice); RO, radiation oncologist; JASTRO, Japanese Society of Therapeutic Radiology and Oncology
[a] Percentage calculated from the number of systems using this function and the total number of Linac systems
[b] Percentage calculated from the number of patients and the number of Linac systems. Facilities without Linacs were excluded from the calculation
[c] Percentage of facilities which have equipment

Table 3. Equipment, its function, and patient load per equipment in designated cancer care hospitals and the other RT facilities

	Designated cancer care hospitals (n = 326)		Other RT facilities (n = 386)		P-value	Total (n = 712)	
	n	%	n	%		n	%
Linac	397	96.3[a]	368	88.9[a]	0.0002	765	92.3[a]
With dual-energy function	291	73.1[b]	207	56.3[b]	<0.0001	498	65.1[b]
With 3D-CRT function (MLC width =<1.0 cm)	268	67.5[b]	194	52.7[b]	<0.0001	462	60.4[b]
With IMRT function	119	30.0[b]	51	13.9[b]	<0.0001	170	22.2[b]
Average no. Linacs/facility	1.2		1.0		<0.0001	1.1	
Annual no. patients/Linac	289.7[c]		175.1[c]		<0.0001	234.6[c]	
Telecobalt (actual use)	18 (7)		16 (4)			34 (11)	
Gamma Knife	17		31		0.1400	48	
^{60}Co RALS (actual use)	51 (46)	15.6 (14.1)	23 (18)	7.1[c] (5.5)	<0.0001	74 (64)	10.4[c] (9.0)
^{192}Ir RALS (actual use)	94 (91)	28.5[c] (27.6)	29 (28)	8.9[c] (8.6)	<0.0001	123 (119)	17.1[c] (16.6)

3D-CRT, three-dimensional conformal RT; other abbreviations as in Table 2
[a] Percentage of facilities which have this equipment (two or more pieces of equipment per facility)
[b] Percentage calculated from the number of systems using this function and the total number of Linac systems
[c] Percentage calculated from the number of patients and the number of Linac systems. Facilities without Linacs were excluded from the calculation

were 207 (56.3%), 194 (52.7%), and 51 (13.9%), respectively. The functions of Linac showed significant superiority, approximately 15% greater, in designated cancer care hospitals compared with the other RT facilities ($P < 0.0001$). The patient loads/Linac were 289.7 for designated cancer care hospitals and 175.1 for the other RT facilities ($P < 0.0001$). Fig. 1 shows the distribution of annual patient load/ Linac in designated cancer care hospitals and the other RT facilities. Eighteen percent of designated cancer care hospitals and 6% of the other RT facilities were subject to treatment that exceeded the warning level of the Japanese Blue Book Guidelines,[5] of 400 patients/Linac. However, the average patient load/Linac in the other RT facilities was less than the guideline level.

Table 4 shows the RT planning and other equipment patterns. X-ray simulators were installed in 79.1% of the designated cancer care hospitals and 61.7% of the other RT facilities. CT simulators were installed in 63.5% and 48.4%, respectively. A noteworthy difference was found between designated cancer care hospitals and the other RT facilities in the rate of X-ray simulator and CT simulator installation ($P < 0.0001$). Only a very few facilities owned magnetic resonance imaging (MRI) equipment for the RT department, although computer use for RT recording was pervasive in both designated cancer care hospitals and the other RT facilities.

Staffing patterns and patient loads in designated cancer care hospitals and the other RT facilities

Table 5 shows the staffing patterns and patient loads in designated cancer care hospitals and the other RT facilities. We found that 50.3% of the designated cancer care hospitals and 31.9% of the other RT facilities had their own designated RT beds, and ROs also had to care for their inpatients. The total numbers of FTE ROs were 471.3 for the designated cancer care hospitals and 303.2 for the other RT facilities. The average numbers of FTE ROs/facility were 1.4 and 0.9, respectively ($P < 0.0001$). The patient loads/FTE RO were 251.5 and 239.6. Fig. 2 shows the distribution of annual patient load/FTE RO in designated cancer care hospitals and the other RT facilities. Twenty-four percent of designated cancer care hospitals and 11% of the other RT facilities treated more than 300 patients/ RO, which exceeded the warning level of the Japanese Blue Book Guidelines.[5] Fig. 3 shows the percentage of facilities by patient load/FTE RO. The largest number of facilities featured a patient/FTE RO level in the 150–199 range for designated cancer care hospitals and in the 100–149 range for the other RT facilities. The second largest numbers featured patient/FTE RO levels in the 200–249 and 50–99 ranges, respectively. Facilities that had less than 1 FTE RO

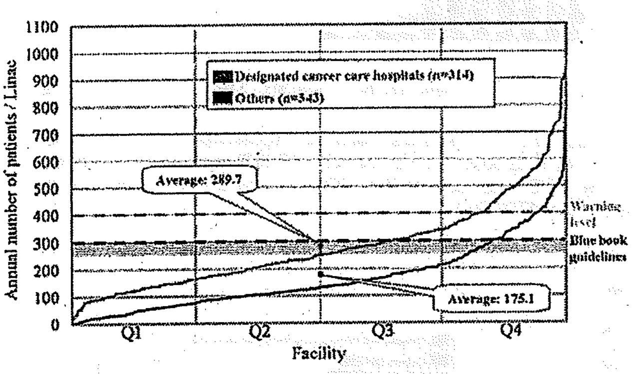

Fig. 1. Distribution of annual patient load/linear accelerator (*Linac*) in designated cancer care hospitals and the other radiotherapy (RT) facilities (*others*). *Horizontal axis* represents facilities arranged in order of increasing annual number of patients/Linac within facilities. The above-mentioned facilities are divided in quaters; *Q1*, 0%–25%; *Q2*, 26%–50%; *Q3*, 51%–75%; *Q4*, 76%–100%

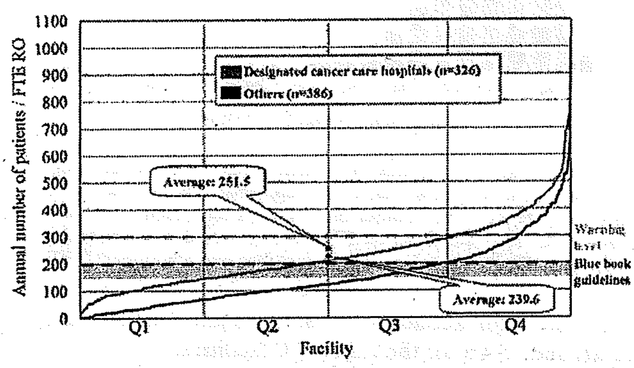

Fig. 2. Distribution of annual patient load/ full-time equivalent radiation oncologist (*FTE RO*) in designated cancer care hospitals and the other RT facilities. *Horizontal axis* represents facilities arranged in order of increasing annual numbers of patients / FTE RO within facilities. The number of FTE ROs for facilities with less than one FTE was calculated as FTE = 1 to avoid overestimating patient load / FTE RO. *Q1-Q4*, as in Fig. 1 legend

Table 4. Radiotherapy planning and other equipment in designated cancer care hospitals and the other RT facilities

	Designated cancer care hospitals ($n = 326$)		Other RT facilities ($n = 386$)		*P*-value	Total ($n = 712$)	
	n	%	*n*	%		*n*	%
X-ray simulator	262	79.1[a]	240	61.7[a]	<0.0001	502	69.7[a]
CT simulator	217	63.5[a]	190	48.4[a]	<0.0001	407	55.3[a]
RTP computer (>= 2)	510 (101)	96.3[a] (38.5)	430 (45)	90.4[a] (11.7)	0.0019 (<0.0001)	940 (146)	93.1[a] (20.5)
MRI (>= 2)	588 (203)	97.5[a] (77.5)	524 (135)	92.2[a] (35.0)	0.0017 (<0.0001)	1112 (338)	94.7[a] (47.5)
For RT only	6	1.8[a]	6	1.6[a]	–	12	1.7[a]
Computer use for RT recording	298	91.4[a]	328	85.0[a]	0.0086	626	87.9[a]

RTP, RT planning; MRI, magnetic resonance imaging; RT, radiotherapy; other abbreviations as in Table 2
[a]Percentage of institutions which have equipment (two or more pieces of equipment per institution)

Table 5. Staffing patterns and patient loads in designated cancer care hospitals and the other RT facilities

	Designated cancer care hospitals (n = 326)	Other RT facilities (n = 386)	P-value	Total (n = 712)
Facilities with RT beds	164 (50.3)	123 (31.9)		287 (40.3)
Average no. RT beds/facility	4.8	3.0	0.0001	3.6
Total (full-time + part-time) FTE ROs	471.3	303.2		774.5
Average no. FTE ROs/facility	1.4	0.9	<0.0001	1.1
No. of JASTRO-certified ROs (full-time)	293	133		426
Average no. JASTRO-certified ROs/facility	0.9	0.4	<0.0001	0.6
Patient load/FTE RO	251.5	239.6	0.0641	246.8
Total no. of RT technologists	889.9	744.6		1634.5
Average no. of RT technologists/facility	2.7	2.3	<0.0001	2.3
Patient load/RT technologist	133.2	97.5	<0.0001	117.0
Full-time medical physicists + part-time	65.0 + 17.1	52.0 + 13.0		117.0 + 30.1
Full-time RT QA staff + part-time	156.0 + 8.0	100.8 + 5.0		256.8 + 13.0
Total no. of nurses/assistants/clerks	476.8	430.2		907.0

Data values in parentheses are percentages
QA, quality assurance; other abbreviations as in Table 2

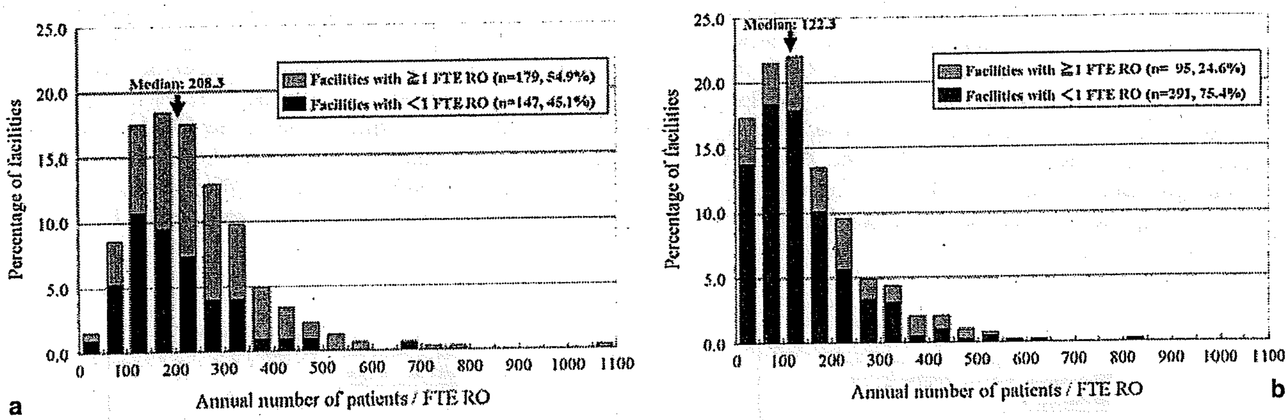

Fig. 3. **a** Percentage of facilities by patient load / FTE RO in designated cancer care hospitals. *Each bar* represents an interval of 50 patients per FTE RO. The number of FTE ROs for facilities with less than one FTE was calculated as FTE = 1 to avoid overestimating patient load / FTE RO. **b** Percentage of facilities by patient load / FTE RO in the other RT facilities. *Each bar* represents an interval of 50 patients per FTE RO. The number of FTE ROs for facilities with less than one FTE was calculated as FTE = 1 to avoid overestimating patient load / FTE RO

still accounted for about 45.1% of designated cancer care hospitals and 75.4% of the other RT facilities.

The total numbers of RT technologists were 889.9 for designated cancer care hospitals and 744.6 for the other RT facilities. The average numbers of RT technologists in the two types of facilities were 2.7 and 2.3, respectively (P < 0.0001). The patient loads/RT technologist were 133.2 and 97.5, respectively (P < 0.0001). Fig. 4 shows the distribution of annual patient load/RT technologist in designated cancer care hospitals and the other RT facilities. Fourteen percent of designated cancer care hospitals and 8% of the other RT facilities treated more than 200 patients per RT technologist, exceeding the warning level of the Japanese Blue Book Guidelines.[5] Fig. 5 shows the percentage of facilities by patient load/RT technologist. The largest number of facilities featured a patient/RT technologist level in the 80–99 range for both designated cancer care hospitals and the other RT facilities. The second largest numbers featured patient/RT technologist levels in the ranges of 100–119 and 60–79, respectively.

There were 65.0 FT (and 17.1 part-time) medical physicists for designated cancer care hospitals and 52.0 FT (and 13.0 part-time) medical physicists for the other RT facilities. There were 156.0 FT (and 8.0 part-time) RT quality assurance staff for designated cancer care hospitals and 100.8 FT (and 5.0 part-time) RT quality assurance staff for the other

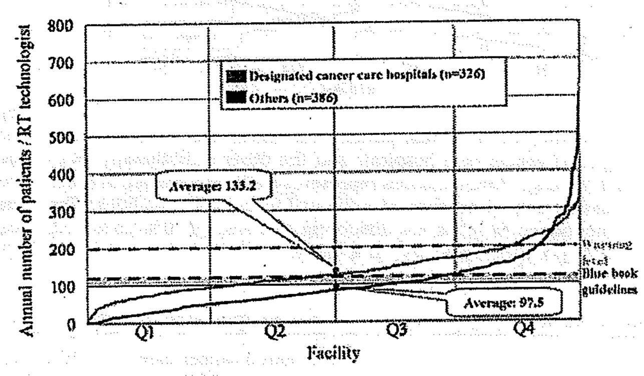

Fig. 4. Distribution of annual patient load / RT technologist in designated cancer care hospitals and the other RT facilities. *Horizontal axis* represents facilities arranged in order of increasing annual number of patients / RT technologist within facilities. *Q1-Q4*, As in Fig. 1 legend

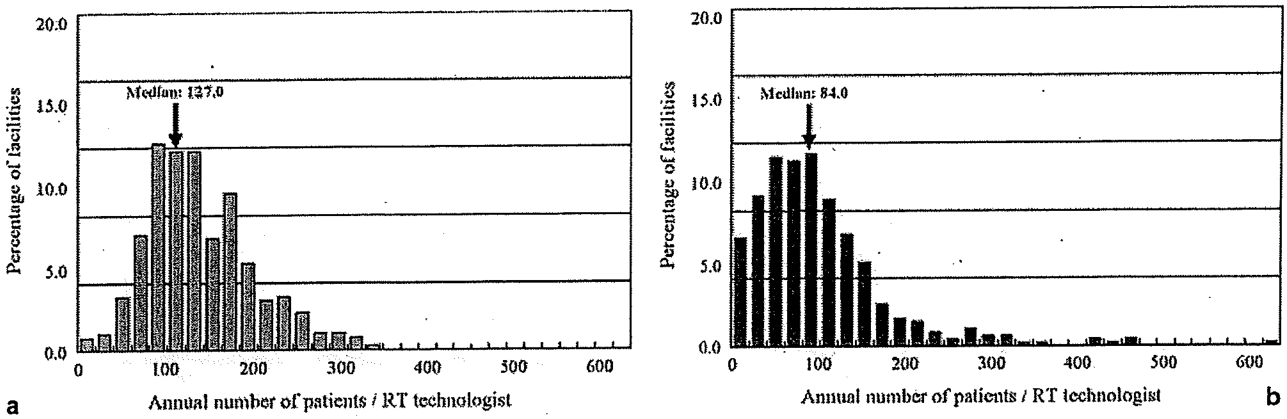

Fig. 5. **a** Percentage of facilities by patient load / RT technologist in designated cancer care hospitals. *Each bar* represents an interval of 20 patients per FTE staff. **b** Percentage of facilities by patient load / RT technologist in the other RT facilities. *Each bar* represents an interval of 20 patients per FTE staff

Table 6. Primary disease sites, and brain metastasis and bone metastasis treated with RT in designated cancer care hospitals and the other RT facilities

Primary site	Designated cancer care hospitals (n = 321)		Other RT facilities (n = 380)		P-value	Total (n = 701)	
	n	%	n	%		n	%
Cerebrospinal	4130	4.3	4469	7.7	<0.0001	8599	5.6
Head and neck (including thyroid)	11199	11.6	5174	8.9	<0.0001	16373	10.6
Esophagus	6647	6.9	3566	6.1	<0.0001	10213	6.6
Lung, trachea, and mediastinum	18097	18.8	11943	20.5	<0.0001	30040	19.4
Lung	15341	15.9	10051	17.3	<0.0001	25392	16.4
Breast	18733	19.4	11528	19.8	0.0458	30261	19.6
Liver, biliary, tract, and pancreas	4116	4.3	2239	3.9	<0.0001	6355	4.1
Gastric, small intestine, and colorectal	4868	5.0	2976	5.1	0.5193	7844	5.1
Gynecologic	6277	6.5	2392	4.1	<0.0001	8669	5.6
Urogenital	11380	11.8	7180	12.4	0.0011	18560	12.0
Prostate	8133	8.4	5085	8.7	0.0291	13218	8.6
Hematopoietic and lymphatic	5499	5.7	2541	4.4	<0.0001	8040	5.2
Skin, bone, and soft tissue	3326	3.4	1878	3.2	0.0223	5204	3.4
Other (malignant)	1165	1.2	910	1.6	<0.0001	2075	1.3
Benign tumors	1033	1.1	1323	2.3	<0.0001	2356	1.5
Pediatric <15 years (included in totals above)	577	0.6	470	0.8	<0.0001	1047	0.7
Total	96470	100.0	58119	100.0	<0.0001	154589[a]	100.0
Metastasis	(n = 326)		(n = 386)		P-value	(n = 712)	
Brain	7212	6.1	8109	11.2	<0.0001	15321	8.0
Bone	16968	14.3	10508	14.5	0.3464	27476	14.4

[a]Total number of new patients was different from this number, because no data on primary sites were reported by some facilities

RT facilities. Finally, there were 476.8 nurses and clerks for designated cancer care hospitals and 430.2 nurses and clerks for the other RT facilities.

Distribution of primary disease sites and palliative treatment in designated cancer care hospitals and the other RT facilities

Table 6 shows the distribution of primary disease sites and palliative treatment in the designated cancer care hospitals and the other RT facilities. The most common disease site in designated cancer care hospitals was the breast; in the other RT facilities, it was lung/bronchus/mediastinum. Head/neck, esophagus, liver/biliary tract/pancreas, gynecologic, hematopoietic/lymphatic, and skin/bone/soft tissue cancers were treated at higher rates at designated cancer care hospitals than at the other RT facilities (skin/bone/soft tissue cancer, $P = 0.0223$; other cancers, $P < 0.0001$). The other RT facilities treated more patients with brain metastasis (11.2% of all new patients) than the designated cancer care hospitals ($P < 0.0001$).

Geographic patterns in designated cancer care hospitals and the other RT facilities

Fig. 6 a,b shows the geographic distribution, for 47 prefectures, of the number of RT facilities arranged in order of increasing population by all prefectures in Japan (Fig. 6a)

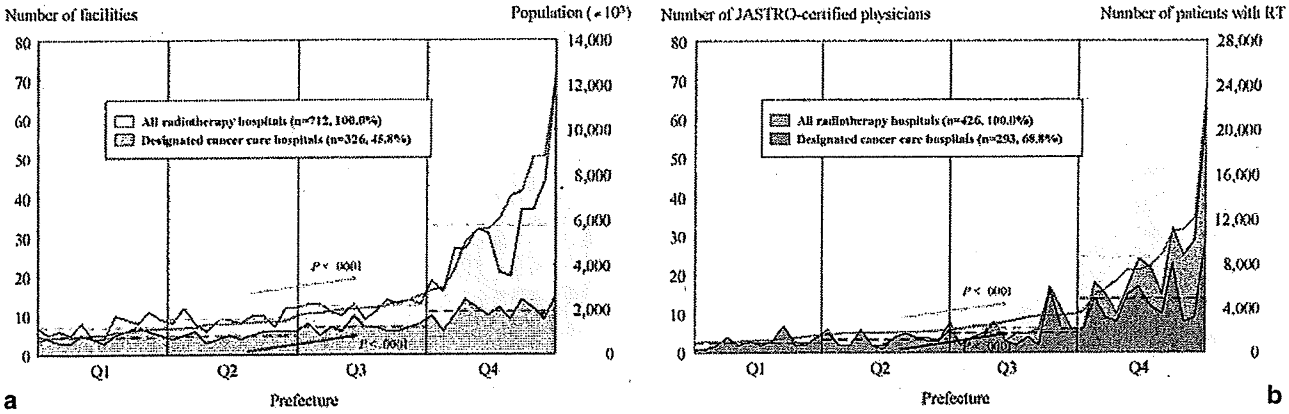

Fig. 6. **a** Geographic distribution, for 47 prefectures, of the number of facilities arranged in order of increasing population. *Upper dashed horizontal bar* shows average number of facilities in the prefectures per 4 separated groups (Q1–Q4) in all RT hospitals, and *lower dashed horizontal bar* shows that number in designated cancer care hospitals. **b** Geographic distribution, for 47 prefectures, of the number of Japanese Society of Therapeutic Radiology and Oncology (*JASTRO*)-certified physicians, arranged in increasing order of the number of patients undergoing RT, by prefecture. *Upper horizontal dashed bar* shows average number of JASTRO-certified physicians in the prefectures per quarter in all RT hospitals, and *lower dashed horizontal bar* shows that number in designated cancer care hospitals. *Q1-Q4*, As in Fig. 1 legend

and the number of JASTRO-certified physicians, arranged in order of increasing number of patients undergoing RT, by all prefectures in Japan (Fig. 6b).[7] The average number of RT facilities per 4 separated groups (Q1–Q4) ranged from 7.2 to 32.9 in all RT facilities in Japan. In designated cancer care hospitals, these numbers ranged from 4.7 to 11.2. There were significant differences in the average number of facilities per quarter in both all RT facilities and in designated cancer care hospitals (both, $P < 0.0001$). The average number of JASTRO-certified physicians per quarter ranged from 2.8 to 24.5 in all RT facilities in Japan. In designated cancer care hospitals, these numbers ranged from 2.8 to 14.0. The average number of JASTRO-certified physicians per quarter showed significant differences in both all RT facilities and designated cancer care hospitals (both, $P < 0.0001$).

Discussion

The number of patients in designated cancer care hospitals was 61.1% of the number of patients (both new patients and the total number of patients) in all RT facilities in Japan, although the designated cancer care hospitals accounted for 45.3% of all RT facilities. About 62 % of all RT facilities have less than 1 FTE RO, while about 45% of designated cancer care hospitals have less than 1 FTE RO. In Japan, the majority of facilities still rely on part-time ROs, especially in the facilities other than the designated cancer care hospitals. The percentage distribution of facilities by patient load/RO in designated cancer care hospitals proved to be largely similar to that of the United States in 1989.[8] However, facilities which have less than 1 FTE RO still account for about 45% of designated cancer care hospitals in Japan. In the United States, all facilities are supported by a full-time RO. The percentage distribution of facilities by patient load/RO in the other RT facilities in the present study was largely similar to that found in Japan in 1990,[8] so a shortage of ROs will remain a major concern in Japan. As for medical physicists, their numbers in Japan are still smaller than those in Europe and the United States. They work mainly in metropolitan areas or academic facilities such as university hospitals or cancer centers. At present, there is no national license for a medical physicist in Japan. Those with a master's degree in science or engineering or radiology technologists with enough clinical experience can take the Japan Radiological Society (JRS)-certified examination to become medical physicists. In Japan, a new educational system is developing to train specialists for cancer care, including medical physicists, medical oncologists, oncology nurses, and palliative care doctors. A sufficient number of RT technologists is ensured, as compared with ROs and medical physicists. However, RT technologists are busy, because they also partly play the role of medical physicists in Japan.

In terms of the distribution of the primary disease site for RT, designated cancer care hospitals treated more patients with head and neck cancers, while the other RT facilities treated more patients with cancers of the lung, trachea, and mediastinum Furthermore, more patients with brain or bone metastasis were treated in the other RT facilities. These results imply that designated cancer care hospitals which treat more potentially curative patients have better structures than the other hospitals.

On a regional basis, the number of all RT facilities and the number of designated cancer care hospitals were strongly associated with population (correlation coefficients were 0.95 and 0.83). These results proved that designated cancer care hospitals were in the appropriate places. However, in some regions where there was a large population, the proportion of designated cancer care hospitals was not sufficient, because many university hospitals were not certified by the Ministry of Health, Labour and Welfare as designated cancer care hospitals. There were two prefectures where the number of RT hospitals was extremely small, as shown in the Q4 region of Fig. 6a. They were located in metropolitan areas, so many cancer patients who lived in those areas might have received treatment in the hospitals in Tokyo. The numbers of JASTRO-certified physicians in all RT facilities and in the designated cancer care hospitals were also strongly associated with the number of patients undergoing RT (correlation coefficients were 0.92 and 0.83). The JASTRO-certified physicians were in the appropriate places. However, the absolute number of JASTRO-certified physicians was especially insufficient in regions where there were many patients undergoing RT. As shown in Fig. 6b, there were five peaks in the number of JASTRO-certified physicians in the Q3 and Q4 regions. These peaks were Tokyo, Kanagawa, Chiba, Hiroshima, and Gunma, in descending order. In the Tokyo metropolitan area, the Keihanshin area, and the Chukyo area, cancer patients can easily receive treatment at hospitals that are in other regions because these areas are conveniently located in terms of public transpotation (indicated by the jagged graph in Fig. 6b). In Japan, it is necessary to increase the number of designated cancer care hospitals and the number of JASTRO-certified physicians in regions where there is a large population and many patients.

The utilization rate of RT for new cancer patients in Japan remains at about 25% (162 000/660 578[9]), less than half the ratio in the United States and European countries. The "anti-cancer" law was enacted in Japan to promote RT and education for ROs, medical physicists, and other staff members as of April 2007. In Japan, RT is expected to play an increasingly important role because the increase in the elderly population is the highest among other developed countries.

In the present study, the ownership of all equipment was more firmly in place in designated cancer care hospitals than in the other RT facilities.[10] The function of Linac, in particular the IMRT function, does not mean actual use of its function. In 2005, mainly due to severe shortages of personnel, only 6.0% of Linacs with their function were used for actual IMRT in the clinic. The average number of staff members for RT in designated cancer care hospitals was more than that in the other RT facilities. So, the accreditation of designated cancer care hospitals is closely correlated with the maturity of the structures of radiation oncology.[10] However, it is problematic that there are designated cancer care hospitals without their own RT departments. We consider that all the designated cancer care hospitals need to have their own RT departments, because the number of cancer patients requiring RT is rapidly increasing and currently RT in Japan is underutilized compared with that in Europe and the United States. The accreditation of designated cancer care hospitals by the Ministry of Health, Labour and Welfare would be a good start to consolidate RT facilities geographically in Japan.

The structural information on all RT facilities in Japan is regularly surveyed by JASTRO. Although the process and the outcome of cancer care in patients undergoing RT have been investigated by PCS every 4 years, the collection of the outcome information is insufficient. In the United States, a National Cancer Database was established and it has been collecting the data for cancer care. This database is used as the quality indicator for improvements in the processes and outcomes of cancer care. It is necessary to establish an informational system in Japan that can collect national data for cancer care. We have now established a Japanese National Cancer Database based on the RT data. We are preparing the collection of cancer care data by using this system.

In conclusion, the structure of radiation oncology in designated cancer care hospitals in Japan showed maturity, more so than that of other RT facilities, in terms of equipment and their functions, although a shortage of personnel still exists. It is necessary, as national policy, to solve the problem of the arrangement of designated cancer care hospitals and the shortage of personnel for cancer care as clarified by data in this survey.

Conflict of interest

H. Ikeda received a Grant-in-Aid for Cancer Research (No. 18-2) from the Ministry of Health, Labour and Welfare. The other authors have no conflict of interest.

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SPECIAL ARTICLE

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Comprehensive Registry of Esophageal Cancer in Japan, 2000

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These data were first issued on June 26, 2003, as the *Comprehensive Registry of Esophageal Cancer in 2000*. Not all pages are reprinted here; however, the original table numbers have been kept. New figures showing survival rates were added. Authors were at the time members of the Registration Committee for Esophageal Cancer, the Japan Esophageal Society, and made great contributions in preparing this material.

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I. Clinical Factors of Esophageal Cancer Patients treated in 2000

1. Institutions-registered cases in 2000

Inst#	Institutions
1406	First Dept. of Medicine, Hirosaki Med. Univ. School of Med.
1501	First Dept. of Surg., Iwate Med. Univ. School of Med.
1801	First Dept. of Surg., Tohoku Univ. School of Med.
2101	First Dept. of Surg., Gunma Univ. School of Med.
2102	Second Dept. of Surg., Gumma Univ. School of Med.
2201	Dept. of Gastroenterol. Surg., Jichi Medical School
2301	First Dept. of Surg., Dokkyo Med. Univ. School of Med.
2705	Dept. of Endoscopic Diagnostics & Therapautics, Chiba Univ.
3201	First Dept. of Surg., Nippon Medical School
3303	First Dept. of Surg., Tokyo Med. & Dental Univ. School of Med.
3401	First Dept. of Surg., Juntendo Univ. School of Med.
3501	First Dept. of Surg., Juntendo Univ. School of Med.
3811	Dept. of Surg., Inst. of Gastroenterology, Tokyo Women's Medical Univ.
4001	First Dept.of Surg., Yamanashi Med. Univ. School of Med.
4511	Dept. of Digestive Surg., Kitasato Univ. East Hospital
5101	First Dept. of Surg., Niigata Univ. School of Med.
5301	First Dept. of Surg., Shinshu Univ. School of Med.
5506	Second Dept. of Medicine, Nagoya Univ. School of Med.,
5803	Dept. of Funabiki-Surg., Fujita Health Univ. School of Med.
6304	Dept. of Radiology, Kyoto Univ. School of Med.
6311	Dept. of Surgical Oncology, Kyoto Univ. School of Med.
6502	Second Dept. of Surg., Kansai Medical Univ.
7102	Second Dept. of Surg., Kanazawa Univ. School of Med.
7301	First Dept. of Surg., Kobe Univ. School of Med.
8001	First Dept. of Surg., Okayama Univ. School of Med.
8032	Second Dept. of Surg., Shimane Medical Univ.
8502	Second Dept. of Surg., Yamaguchi Univ. School of Med.
8507	First Dept. of Int. Med., Yamaguchi Univ. School of Med.
8601	First Dept. of Surg., Tokushima Univ. School of Med.
9102	Second Dept. of Surg., Kyushu Univ. School of Med.
9301	Dept. of Surg., Kurume Univ. School of Med.
9302	Medical Center, Kurume Univ. School of Med.
9702	Second Dept. of Surg., Oita Medical Univ.
9991	First Dept. of Surg., Univ. of the Ryukyus School of Med.
9994	Dept. of Radiology, Univ. of the Ryukyus School of Med.
10081	National Shikoku Cancer Center Hospital
10091	National Kyushu Cancer Center Hospital
11201	Dept. of Surg., Sendai National Hospital
14401	Dept. of Surg., Kasumigaura National Hospital
14801	National Kanazawa Hospital
17601	National Iwakuni Hospital
21041	Dept. of Surg., Yamagata Prefectual Central Hospital
21091	Dept. of Surg., Iwaki City Sogo Iwakikyoritsu Hospital
23011	Dept. of Surg., Metropolitan Komagome General Hospital
23017	Dept. of Gastroenterol., Metropolitan Komagome General Hospital
24011	Dept. of Surg., Gunma Cancer Center Toumou Hospital
24031	Dept. of Surg., Tochigi Cancer Center
25032	Dept. of Thoracic Surg., Aichi Cancer Center
26011	Osaka Adult Disease Center
27031	Dept. of Surg., Hyogo Prefectual Kakogawa Hospital
27041	Dept. of Surg., Tottori Prefectual Central Hospital
29011	Dept. of Surg., Saga Prefectual Kouseikan Hospital
34021	Urawa Municipal Hospital
34051	Dept. of Surg., Numazu City Hospital
34061	Kakegawa Municipal Hospital
34131	Hiratsuka City Hospital
34151	Dept. of Surg., Yamato City Hospital
35041	Dept. of Surg., Gifu City Hospital
36041	Dept. of Surg., Suita City Hospital
36081	Dept. of Surg., Izumi City Hospital
37111	Dept. of Surg., Kobe City Central Hospital
37200	Hiroshima City Asa Hospital
37211	Dept. of Surg., Matsue City Hospital
39121	Dept. of Surg., Kitakyushu City Yahata Hospital
40311	Dept. of Surg., Toranomon Hospital
40711	Dept. of Surg., Kinki Center Hospital
42121	Akita Red Cross Hospital
42211	Dept. of Surg., Nagaoka Red Cross Hospital
42311	Japanese Red Cross Medical Center
42831	Dept. of Surg., Matsuyama Red Cross Hospitral
43131	Dept. of Surg., Akita Rosai Hospital
43611	Dept. of Surg., Osaka Rosai Hospital
44311	Dept. of Surg., Social Insurance General Center Hospital
44411	Dept. of Surg., Social Insurance Saitama Center Hospital
44541	Social Insurance Chukyo Hospital
45111	Dept. of Medicine, Yamamoto Union General Hospital
46011	Obihiro Kousei Hospital
47421	Dept. of Surg., Yokosuka Kyosai Hospital
48611	Dept. of Surg., Osaka Teishin Hospital
50001	Dept. of Surg., Cancer Institute Hospital
60021	Dept. of Surg., Obihiro Kyokai Hospital
60041	Dept. of Surg., Keiyukai Sapporo Hospital
61051	Dept. of Surg., Hiratsuka Sogo Hospital
64502	Kamitsuga General Hospital
65131	Dept. of Surg., Daiyukai General Hospital
66371	Dept. of Surg., Osaka Police Hospital
67111	Dept. of Surg., Shinko Hospital

2. Patient Background

Table 1) Age, gender and treatment

Age	Cases (%)	Male	Female	Unknown	EMR*/ Stenting	Chemotherapy/ Radiotherapy	Palliative operation	Esopha-gectomy	None/ Unknown
~29	3 (0.2%)	2	1	0	0	2	0	1	0
30~39	4 (0.2%)	4	0	0	1	0	0	3	0
40~49	84 (4.7%)	70	14	0	7	13	1	60	3
50~59	486 (27.3%)	428	58	0	48	91	2	337	8
60~69	661 (37.1%)	599	62	0	69	151	5	414	22
70~79	457 (25.7%)	394	63	0	68	133	2	244	10
80~89	77 (4.3%)	63	14	0	12	37	3	22	3
90~	4 (0.2%)	3	1	0	0	3	0	1	0
Unknown	5 (0.3%)	5	0	0	3	1	0	1	0
Total	1781 (100%)	1568 (88.0%)	213 (12.0%)	0	208 (11.7%)	431 (24.2%)	13 (0.7%)	1083 (60.8%)	46 (2.6%)

*EMR: endoscopic mucosal resection

Table 2) Area of patient's residence and occupation

Area	No. of cases (%)	Area	No. of cases (%)
Total	**1781 (100%)**	Miyazaki	0 (0.0%)
Aichi	65 (3.7%)	Nagano	14 (0.8%)
Akita	39 (2.2%)	Nagasaki	8 (0.4%)
Aomori	5 (0.3%)	Nara	6 (0.3%)
Chiba	44 (2.5%)	Niigata	48 (2.7%)
Ehime	29 (1.6%)	Oita	34 (1.9%)
Fukui	0 (0.0%)	Okayama	31 (1.7%)
Fukuoka	112 (6.3%)	Okinawa	5 (0.3%)
Fukushima	11 (1.2%)	Osaka	115 (6.5%)
Gifu	20 (0.6%)	Saga	22 (1.2%)
Gunma	51 (2.9%)	Saitama	94 (5.3%)
Hiroshima	23 (1.3%)	Shiga	4 (0.2%)
Hokkaido	190 (10.7%)	Shimane	18 (1.0%)
Hyogo	96 (5.4%)	Shizuoka	29 (1.7%)
Ibaraki	21 (1.2%)	Tochigi	99 (5.6%)
Ishikawa	8 (0.4%)	Tokushima	7 (0.4%)
Iwate	33 (1.9%)	Tokyo	294 (16.5%)
Kagawa	2 (0.1%)	Tottori	6 (0.3%)
Kagoshima	3 (0.2%)	Toyama	3 (0.2%)
Kanagawa	81 (4.5%)	Wakayama	0 (0.0%)
Kouchi	1 (0.06%)	Yamagata	15 (0.8%)
Kumamoto	4 (0.2%)	Yamaguchi	16 (0.9%)
Kyoto	28 (1.6%)	Yamanashi	12 (0.7%)
Mie	11 (0.6%)	Others	2 (0.1%)
Miyagi	15 (0.8%)	Unknown	7 (0.4%)

Occupation	Cases (%)
None	248 (13.9%)
Professional	147 (8.3%)
Management	155 (8.7%)
Office worker	295 (16.6%)
Sales worker	98 (5.5%)
Farm/Forestry/Fishery	112 (6.3%)
Mining and Quarrying	13 (0.7%)
Transport and communication	53 (3.0%)
Industrial technician	93 (5.2%)
General worker/Service industry	94 (5.3%)
Others	35 (2.0%)
Unclassified	7 (0.4%)
Unknown	431 (24.2%)
Total	1781 (100%)

Table 3) Familial history of carcinoma

Familial history	Cases (%)
No	989 (55.5%)
Yes	527 (29.6%)
Unknown	265 (14.9%)
Total	1781 (100%)

Table 4) Tumors in familial history of carcinoma

Diseases	No. of cases (%)	Diseases	No. of cases (%)
Malig. lymphoma	4 (0.6%)	Gallbladder ca.	5 (0.7%)
Leukemia	8 (1.1%)	Pancreas ca.	31 (4.4%)
Brain tumor	4 (0.6%)	Colon ca.	44 (6.3%)
Mandibular ca.	2 (0.3%)	Rectal ca.	20 (2.8%)
Paranasal sinus ca.	0 (0.0%)	Uterus ca.	45 (6.4%)
Thyroid ca.	2 (0.3%)	Ovarian ca.	7 (1.0%)
Breast ca.	30 (4.3%)	Seminoma	0 (0.0%)
Lung ca.	90 (12.8%)	Renal ca.	2 (0.3%)
Maxilla ca.	0 (0.0%)	Bladder ca.	12 (1.7%)
Tongue ca.	4 (0.6%)	Prostate ca.	6 (0.9%)
Oral ca.	0 (0.0%)	Osteosarcoma	0 (0.0%)
Pharyngeal ca.	4 (0.6%)	Spinal tumor	0 (0.0%)
Laryngeal ca.	16 (2.3%)	Malig. melanoma	0 (0.0%)
Esophageal ca.	69 (9.8%)	Skin ca.	3 (0.4%)
Gastric ca.	216 (30.7%)	Others	1 (0.1%)
Hepatoma	52 (7.4%)	Unknown	18 (2.6%)
Cholangioma	8 (1.1%)		
Jejunal ca.	0 (0.0%)	Total cases (%)	704 (100%)
Duodenal ca..	1 (0.1%)	No. of patients	527

Table 5) Reason and basis for diagnosis according to clinical T-category

Reason for diagnosis	Superficial cancer (cTis cT1)	Advanced cancer (cT2 cT3 cT4)	Total (%)
Chief complaint	164 (31.4%)	998 (82.5%)	1162 (69.7%)
Detection survey / dock	215 (41.2%)	88 (7.8%)	303 (18.2%)
Examination for other disease	137 (26.2%)	51 (4.5%)	188 (11.3%)
Unknown	6 (1.1%)	9 (5.2%)	15 (0.9%)
Total	522 (100%)	1146 (100%)	1668* (100%)

Detection methods	Superficial cancer (cTis cT1)	Advanced cancer (cT2 cT3 cT4)	Total (%)
Esophagography	44 (8.4%)	243 (21.2%)	287 (17.2%)
Esophagoscopy	470 (90.0%)	848 (74.0%)	1318 (79.0%)
CT-scan	0	15 (1.3%)	15 (0.9%)
US	0	1 (0.1%)	1 (0.06%)
Biopsy	0	5 (0.4%)	5 (0.3%)
Others	1 (0.2%)	2 (0.2%)	3 (0.2%)
Unknown	7 (1.3%)	32 (2.8%)	39 (2.3%)
Total	522 (100%)	1146 (100%)	1668* (100%)

*: excluding 113 cTX, cT0, cT unknown cases

Table 6) Symptoms according to clinical T-category

Symptom	cTis cT1	cT2 cT3 cT4	Total (%)
	Cases (%)	Cases (%)	
None	317 (60.7%)	96 (8.4%)	413 (24.8%)
Chest pain	28 (5.4%)	37 (3.2%)	65 (3.9%)
Sense of stricture	45 (8.6%)	495 (43.2%)	540 (32.4%)
Unusual sensation	34 (6.5%)	49 (4.3%)	83 (5.0%)
Dysphagia	15 (2.9%)	329 (28.7%)	344 (20.6%)
Nausea / Vomiting	5 (1.0%)	27 (2.4%)	32 (2.0%)
Appetite loss	10 (1.9%)	14 (1.2%)	24 (1.4%)
Weight loss	7 (1.3%)	12 (1.0%)	19 (1.1%)
Swollen lymph node(s)	7 (1.3%)	7 (0.6%)	14 (0.8%)
Hoarseness	1 (0.2%)	21 (1.8%)	22 (1.3%)
Others	32 (6.1%)	38 (3.3%)	70 (4.2%)
Unknown	21 (4.0%)	21 (1.8%)	42 (2.5%)
Total	522 (100%)	1146 (100%)	1668* (100%)

*: excluding 113 cTX, cT0, cT unknown cases

Table 7) Double / multiple primary cancers

	Endoscopic treatment (EMR/Stenting)	Chemotherapy and/or radiotherapy	Surgery		Total (%)
			Palliative operation	Esophagectomy	
None	127 (61.1%)	325 (75.4%)	12 (92.3%)	861 (79.5%)	1325 (76.3%)
Double	24 (11.5%)	44 (10.2%)	0	116 (10.7%)	184 (10.6%)
Metachronous					
Before E-Ca	42 (20.2%)	49 (11.4%)	0	76 (7.0%)	167 (9.6%)
After E-Ca	2 (1.0%)	1 (0.2%)	0	17 (1.6%)	20 (1.2%)
Multiple	5 (2.4%)	4 (0.9%)	0	8 (0.7%)	17 (1.0%)
Unknown	8 (3.8%)	8 (1.9%)	1 (7.7%)	5 (0.4%)	22 (1.3%)
Total	208 (100 %)	431 (100 %)	13 (100 %)	1083 (100 %)	1735* (100 %)

*: excluding 46 treatment unkown cases

Table 8) Double / multiple primary cancers and organs

Organs	Synchronous	Metachronous	Multiple	Total
Larynx/Maxilla	4 (2.0%)	24 (11.8%)	2 (5.4%)	30 (6.9%)
Pharynx	37 (18.9%)	28 (13.8%)	6 (16.2%)	71 (16.3%)
Oral cavity/gum/tongue	2 (1.0%)	7 (3.4%)	1 (2.7%)	10 (2.3%)
Stomach	93 (47.4%)	70 (34.5%)	9 (24.3%)	172 (39.4%)
Colon/Rectum	25 (12.8%)	18 (8.9%)	4 (10.8%)	47 (10.8%)
Liver	5 (2.6%)	3 (1.5%)	0	8 (1.8%)
Choledochus/Gallbladder	0	1 (0.5%)	1 (2.7%)	2 (0.5%)
Pancreas	2 (1.0%)	2 (1.0%)	0	4 (0.9%)
Lung/trachea/bronchus	7 (3.6%)	14 (6.9%)	1 (2.7%)	22 (5.0%)
Remnant esophagus	1 (0.5%)	7 (3.4%)	1 (2.7%)	9 (2.1%)
Uterus/ovarium	0	2 (1.0%)	0	2 (0.5%)
Breast	0	3 (1.5%)	0	3 (0.7%)
Prostate	2 (1.0%)	1 (0.5%)	1 (2.7%)	4 (0.9%)
Urinary bladder	3 (1.5%)	4 (2.0%)	1 (2.7%)	8 (1.8%)
Leukemia	0	0	1 (2.7%)	1 (0.2%)
Skin	0	1 (0.5%)	1 (2.7%)	2 (0.5%)
Brain	0	1 (0.5%)	0	1 (0.2%)
Thyroid	4 (2.0%)	0	0	4 (0.9%)
Bone	0	1 (0.5%)	0	1 (0.2%)
Kidney	3 (1.5%)	5 (2.5%)	1 (2.7%)	9 (2.1%)
Others	8 (4.1%)	11 (5.4%)	5 (13.5%)	24 (5.5%)
Unknown	0	0	2 (5.4%)	2 (0.5%)
Lesions	196 (100%)	203 (100%)	37 (100%)	436 (100%)
Cases	184	187	17	388

Table 13) Location of tumor

Location	Endoscopic treatment	Chemotherapy and/or radiotherapy	Surgery		Total (%)
			Palliative operation	Esophagectomy	
Not detected	2 (1.0%)	0	0	0	2 (0.1%)
Pharynx	7 (3.4%)	5 (1.2%)	1 (7.7%)	6 (0.6%)	19 (1.1%)
Cervical esophagus	5 (2.4%)	30 (7.0%)	1 (7.7%)	46 (4.2%)	82 (4.7%)
Upper thoracic esoph.	19 (9.1%)	77 (17.9%)	3 (23.1%)	129 (11.9%)	228 (13.1%)
Middle thoracic esoph.	112 (53.8%)	220 (51.0%)	4 (30.8%)	523 (48.3%)	859 (49.5%)
Lower thoracic esoph.	50 (24.0%)	84 (19.5%)	2 (15.4%)	284 (26.2%)	420 (24.2%)
Abdominal esophagus	6 (2.9%)	11 (2.6%)	1 (7.7%)	73 (6.7%)	91 (5.2%)
EG-Junction (E=G)	1 (0.5%)	1 (0.2%)	0	14 (1.3%)	16 (0.9%)
Cardia (G)	0	0	0	3 (0.3%)	3 (0.2%)
Unknown	6 (2.9%)	3 (0.7%)	1 (7.7%)	5 (0.5%)	15 (0.9%)
Total	208 (100%)	431 (100%)	13 (100%)	1083 (100%)	1735 (100%)

Table 14) Longitudinal tumor length on esophagography

Length	Endoscopic treatment	Chemotherapy and/or radiotherapy	Surgery		Total (%)
			Palliative operation	Esophagectomy	
not examined	2 (1.0%)	9 (2.1%)	3 (23.1%)	10 (0.9%)	24 (1.4%)
~1cm	7 (3.4%)	1 (0.2%)	1 (7.7%)	10 (0.9%)	19 (1.1%)
~2cm	24 (11.5%)	9 (2.1%)	0	61 (5.6%)	94 (5.4%)
~3cm	24 (11.5%)	25 (5.8%)	0	92 (8.5%)	141 (8.1%)
~4cm	15 (7.2%)	26 (6.0%)	0	124 (11.4%)	165 (9.5%)
~5cm	4 (1.9%)	39 (9.1%)	1 (7.7%)	132 (12.2%)	176 (10.1%)
~6cm	3 (1.4%)	40 (9.3%)	2 (15.4%)	144 (13.3%)	189 (10.9%)
~7cm	2 (1.0%)	55 (12.8%)	0	125 (11.5%)	182 (10.5%)
~8cm	5 (2.4%)	49 (11.4%)	1 (7.7%)	98 (9.0%)	153 (8.8%)
~9cm	1 (0.5%)	32 (7.4%)	0	70 (6.5%)	103 (5.9%)
~10cm	3 (1.4%)	21 (4.9%)	0	37 (3.4%)	61 (3.5%)
~11cm	1 (0.5%)	26 (6.0%)	0	30 (2.8%)	57 (3.3%)
~12cm	0	12 (2.8%)	0	12 (1.1%)	24 (1.4%)
~13cm	0	6 (1.4%)	1 (7.7%)	10 (0.9%)	17 (1.0%)
~14cm	0	3 (0.7%)	0	1 (0.1%)	4 (0.2%)
~15cm	0	4 (0.9%)	1 (7.7%)	2 (0.2%)	7 (0.4%)
~16cm	0	3 (0.7%)	0	4 (0.4%)	7 (0.4%)
~17cm	0	0	0	1 (0.1%)	1 (0.1%)
17.1cm~	0	1 (0.2%)	0	6 (0.6%)	7 (0.4%)
Unknown	117 (56.2%)	70 (16.2%)	3 (23.1%)	114 (10.5%)	304 (17.5%)
Total	208 (100%)	431 (100%)	13 (100%)	1083 (100%)	1735 (100%)

Table 15) Endoscopic features

Type	Endoscopic treatment	Chemotherapy and/or radiotherapy	Surgery		Total (%)
			Palliative operation	Esophagectomy	
Not examined	0	4 (0.9%)	0	1 (0.1%)	5 (0.3%)
0-I	4 (1.9%)	15 (3.5%)	0	61 (5.6%)	80 (4.6%)
0-IIa	24 (11.5%)	15 (3.5%)	0	74 (6.8%)	113 (6.5%)
0-IIb	24 (11.5%)	3 (0.7%)	1 (7.7%)	24 (2.2%)	52 (3.0%)
0-IIc	124 (59.6%)	43 (10.0%)	0	129 (11.9%)	296 (17.1%)
0-III	0	5 (1.2%)	0	12 (1.1%)	17 (1.0%)
0-V	3 (1.4%)	3 (0.7%)	0	4 (0.4%)	10 (0.6%)
1	2 (1.0%)	20 (4.6%)	1 (7.7%)	70 (6.4%)	93 (5.4%)
2	8 (3.8%)	131 (30.4%)	3 (23.1%)	326 (30.1%)	468 (27.0%)
3	6 (2.9%)	140 (32.5%)	7 (53.8%)	301 (27.8%)	454 (26.2%)
4	3 (1.4%)	9 (2.1%)	0	17 (1.6%)	29 (1.7%)
5	0	7 (1.6%)	0	13 (1.2%)	20 (1.2%)
Unknown	10 (4.8%)	36 (8.4%)	1 (7.7%)	51 (4.7%)	98 (5.6%)
Total	208 (100%)	431 (100%)	13 (100%)	1083 (100%)	1735 (100%)

0- I : superficial and protruding type
0- IIa : superficial and slight elevated type
0- IIb : superficial and flat type
0- IIc : superficial and slightly depressed
0- III : superficial and distinctly depressed

1 : protruding type
2 : ulcerative and localized type
3 : ulcerative and infiltrating type
4 : diffusely infiltrating type
5 : miscellaneous type

Table 17) Depth of tumor invasion cT (clinical TNM-classification)

cT	Endoscopic treatment	Chemotherapy and/or radiotherapy	Surgery		Total (%)
			Palliative operation	Esophagectomy	
cTx	2 (1.0%)	3 (0.7%)	0	1 (0.1%)	6 (0.3%)
cT0	6 (2.9%)	3 (0.7%)	0	4 (0.4%)	13 (0.7%)
cTis	45 (21.6%)	1 (0.2%)	0	8 (0.7%)	54 (3.1%)
cT1	29 (13.9%)	24 (5.6%)	0	58 (5.4%)	111 (6.4%)
cT1a	71 (34.1%)	13 (3.0%)	0	40 (3.7%)	124 (7.1%)
cT1b	13 (6.3%)	34 (7.9%)	0	182 (16.8%)	229 (13.2%)
cT2	2 (1.0%)	41 (9.5%)	1 (7.7%)	171 (15.8%)	215 (12.4%)
cT3	4 (1.9%)	151 (35.0%)	3 (23.1%)	494 (45.6%)	652 (37.6%)
cT4	11 (5.3%)	139 (32.3%)	6 (46.2%)	107 (9.9%)	263 (15.2%)
Unknown	25 (12.0%)	22 (5.1%)	3 (23.1%)	18 (1.7%)	68 (3.9%)
Total	208 (100%)	431 (100%)	13 (100%)	1083 (100%)	1735 (100%)

Table 18) Lymph node metastasis, cN; and organ metastasis, cM (clinical TNM-classification)

cN	Endoscopic treatment	Chemotherapy and/or radiotherapy	Surgery		Total (%)
			Palliative operation	Esophagectomy	
cNx	5 (2.4%)	10 (2.3%)	0	11 (1.0%)	26 (1.5%)
cN0	164 (78.8%)	122 (28.3%)	2 (15.4%)	485 (44.8%)	773 (44.6%)
cN1	13 (6.3%)	272 (63.1%)	8 (61.5%)	567 (52.4%)	860 (49.6%)
Unknown	26 (12.5%)	27 (6.3%)	3 (23.1%)	20 (1.8%)	76 (4.4%)
Total	208 (100%)	431 (100%)	13 (100%)	1083 (100%)	1735 (100%)

cM	Endoscopic treatment	Chemotherapy and/or radiotherapy	Surgery		Total (%)
			Palliative operation	Esophagectomy	
cMx	4 (1.9%)	5 (1.2%)	0	3 (0.3%)	12 (0.7%)
cM0	172 (82.7%)	271 (62.9%)	7 (53.8%)	954 (88.1%)	1404 (80.9%)
cM1	1 (0.5%)	20 (4.6%)	1 (7.7%)	15 (1.4%)	37 (2.1%)
cM1a	2 (1.0%)	31 (7.2%)	2 (15.4%)	42 (3.9%)	77 (4.4%)
cM1b	4 (1.9%)	83 (19.3%)	0	49 (4.5%)	136 (7.8%)
Unknown	25 (12.0%)	21 (4.9%)	3 (23.1%)	20 (1.8%)	69 (4.0%)
Total	208 (100%)	431 (100%)	13 (100%)	1083 (100%)	1735 (100%)

Table 19) Metastatic organs in cM1 cases (clinical TNM classification)

Metastatic organs	Endoscopic treatment	Chemotherapy and/or radiotherapy	Surgery		Total (%)
			Palliative operation	Esophagectomy	
PUL	1 (3.0%)	22 (11.9%)	0	8 (6.1%)	31 (8.7%)
OSS	0	9 (4.9%)	0	3 (2.3%)	12 (3.4%)
HEP	2 (6.1%)	34 (18.4%)	0	7 (5.3%)	43 (12.1%)
BRA	0	2 (1.1%)	0	0	2 (0.6%)
LYM	3 (9.1%)	81 (43.8%)	2 (33.3%)	83 (62.9%)	169 (47.5%)
MAR	0	0	0	0	0
PLE	0	0	0	1 (0.8%)	1 (0.3%)
PER	0	0	0	0	0
SKI	0	1 (0.5%)	0	2 (1.5%)	3 (0.8%)
OTH	0	2 (1.1%)	0	0	2 (0.6%)
Unknown	27 (81.8%)	34 (18.4%)	4 (66.7%)	28 (21.2%)	93 (26.1%)
Lesions	33 (100%)	185 (100%)	6 (100%)	132 (100%)	356 (100%)
One organ	4 (12.5%)	97 (62.6%)	2 (33.3%)	92 (73.0%)	195 (61.1%)
Two organs	1 (3.1%)	18 (11.6%)	0	5 (4.0%)	24 (7.5%)
Three organs	0	6 (3.9%)	0	1 (0.8%)	7 (2.2%)
Four organs~	0	0	0	0	0
Unknown	27 (84.4%)	34 (21.9%)	4 (66.7%)	28 (22.2%)	93 (29.2%)
Total cases	32 (100%)	155 (100%)	6 (100%)	126 (100%)	319 (100%)

Table 20) Clinical stage (clinical TNM-classificacation)

cStage	Endoscopic treatment	Chemotherapy and/or radiotherapy	Surgery		Total (%)
			Palliative operation	Esophagectomy	
0	64 (30.8%)	2 (0.5%)	0	11 (1.0%)	77 (4.4%)
I	93 (44.7%)	50 (11.6%)	0	225 (20.8%)	368 (21.2%)
IIA	2 (1.0%)	38 (8.8%)	0	221 (20.4%)	261 (15.0%)
IIB	1 (0.5%)	17 (3.9%)	0	109 (10.1%)	127 (7.3%)
III	8 (3.8%)	151 (35.0%)	7 (53.8%)	378 (34.9%)	544 (31.4%)
IV	1 (0.5%)	18 (4.2%)	1 (7.7%)	14 (1.3%)	34 (2.0%)
IVA	2 (1.0%)	30 (7.0%)	2 (15.4%)	42 (3.9%)	76 (4.4%)
IVB	4 (1.9%)	83 (19.3%)	0	49 (4.5%)	136 (7.8%)
Unknown	33 (15.9%)	42 (9.7%)	3 (23.1%)	34 (3.1%)	112 (6.5%)
Total	208 (100%)	431 (100%)	13 (100%)	1083 (100%)	1735 (100%)

II. Clinical Results in Patients treated Endoscopically in 2000

Table 21) Treatment details in patients with endoscopic treatment

Treatment details	Cases	(%)
Endoscopic treatment only	201	(96.6%)
Endoscopic treatment + Radiotherapy	1	(0.5%)
Endoscopic treatment + Chemotherapy	6	(2.9%)
Endoscopic treatment + Hyperthermia	0	
Endoscopic treatment + Chemoradiotherapy	0	
Total	208	(100%)

Treatment details	Cases	(%)
EMR	168	(80.8%)
EMR+PDT	3	(1.4%)
EMR+YAG laser	2	(1.0%)
EMR+MCT	0	
EMR+Esophageal stenting	0	
EMR+Other treatment	12	(5.8%)
Esophageal stenting	19	(9.1%)
Tracheal stenting	1	(0.5%)
Esophageal stenting + tracheal stenting	1	(0.5%)
Others	2	(1.0%)
Total	208	(100%)

EMR: endoscopic mucosal resection
PDT: photodynamic therapy
MCT:microwave coaguration therapy

Table 22) Endoscopic mucosal resection (EMR)

Method of EMR	Cases	(%)
One piece resection	88	(47.6%)
Piecemeal resection	89	(48.1%)
Unknown	8	(4.3%)
Total	185	(100%)

No. of lesions treated by EMR	Cases	(%)
1	102	(55.1%)
2	23	(12.4%)
3	12	(6.5%)
4	6	(3.2%)
5	2	(1.1%)
6	1	(0.5%)
7	1	(0.5%)
8	0	
9	0	
10 and/or over	0	
Unknown	38	(20.5%)
Total	185	(100%)

Radicality of EMR	Cases	(%)
Complete resection	130	(70.3%)
Non-complete resection	37	(20.0%)
Unknown	18	(9.7%)
Total	185	(100%)

Complications of EMR	Cases	(%)
None	159	(85.9%)
Perforation	2	(1.1%)
Bleeding	3	(1.6%)
Mediastinitis	0	
Stenosis	6	(3.2%)
Others	0	
Unknown	15	(8.1%)
Total	185	(100%)

Table 24) Histologic findings of EMR specimens (tumor size, histologic type, and depth of tumor invasion)

Size of lesion	Cases (%)
~ 9mm	13 (7.0%)
10 ~19mm	41 (22.2%)
20~29mm	22 (11.9%)
30~39mm	16 (8.7%)
40~49mm	2 (1.1%)
50~59mm	3 (1.6%)
60~69mm	1 (0.5%)
70mm~	0
Unknown	87 (47.0%)
Total	185 (100%)

Histologic type of EMR specimen	Cases (%)
Squamous cell ca (SCC)	97 (52.4%)
Well diff. SCC	15 (8.1%)
Moderately diff. SCC	32 (17.3%)
Poorly diff. SCC	1 (0.5%)
Adenocarcinoma	1 (0.5%)
Barrett's carcinoma	0
Dysplasia	3 (1.6%)
Others	0
Unknown	36 (19.5%)
Total	185 (100%)

Pathological depth of tumor invasion (pT)	Cases (%)
pT0	0
pTis	56 (30.3%)
pT1a(lpm)	32 (17.3%)
pT1a(mm)	41 (22.2%)
pT1b(sm)	16 (8.6%)
Unknown	40 (21.6%)
Total	185 (100%)

Subclassification of histological depth of invasion in superficial cancer	Cases (%)
m1(ep)	56 (30.3%)
m2(lpm)	32 (17.3%)
m3(mm)	41 (22.2%)
sm1	6 (3.2%)
sm2	7 (3.8%)
sm3	2 (1.1%)
Unknown	41 (22.2%)
Total	185 (100%)

ep: epithelium
lpm: lamina propria mucosa
mm: muscularis mucosa
SCC: squares cell carcinoma

Table 25) Histologic findings of EMR specimens (intraepithelial spread, vessel invasion, multiple cancer, and multiple lesion)

Intraepithelial spread (ie)	Cases (%)
(-)	34 (18.4%)
(+)	21 (11.4%)
(+++) superficial spread	1 (0.5%)
Unknown	129 (69.7%)
Total	185 (100%)

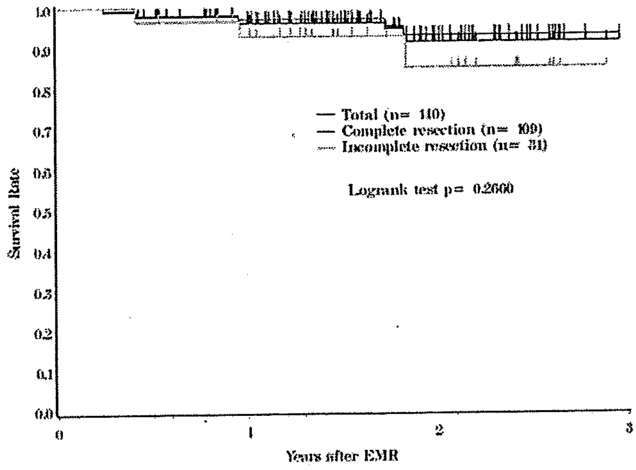
Lymphatic vessel invasion (ly)	Cases (%)
(-)	112 (60.5%)
(+)	11 (6.0%)
Unknown	62 (33.5%)
Total	185 (100%)

Blood vessel invasion (v)	Cases (%)
(-)	119 (64.7%)
(+)	5 (2.7%)
Unknown	60 (32.6%)
Total	185 (100%)

Multiple primary cancer	Cases (%)
(-)	53 (28.6%)
(+)	8 (4.3%)
Unknown	124 (67.0%)
Total	185 (100%)

Multiple malignant lesions	Cases (%)
(-)	56 (30.3%)
(+)	6 (3.2%)
Unknown	123 (66.5%)
Total	185 (100%)

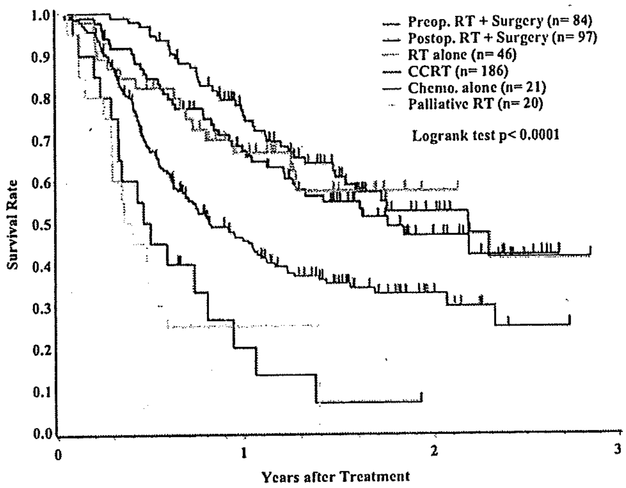
No. of multiple primary lesions	Cases (%)
2	3 (50.0%)
3	1 (16.7%)
5	0
Unknown	2 (33.3%)
Total	6 (100%)



	Years after EMR		
	1	2	3
Total	96.1%	91.2%	91.2%
Complete resection	97.1%	93.0%	93.0%
Incomplete resection	92.7%	85.0%	85.0%

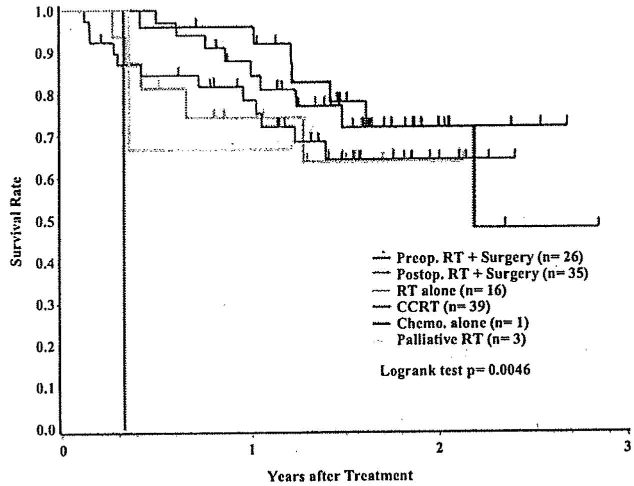
Figure 1 Survival of patients treated with EMR

III. Clinical Results in Patients treated with Chemotherapy and/or Radiotherapy in 2000



	Years after Treatment		
	1	2	3
Preop. RT + Surgery	67.0%	46.7%	42.1%
Postop. RT + Surgery	75.5%	52.5%	-
RT alone	66.6%	57.4%	-
CCRT	45.6%	32.8%	24.8%
Chemo. alone	20.0%	-	-
Palliative RT	25.0%	–	–

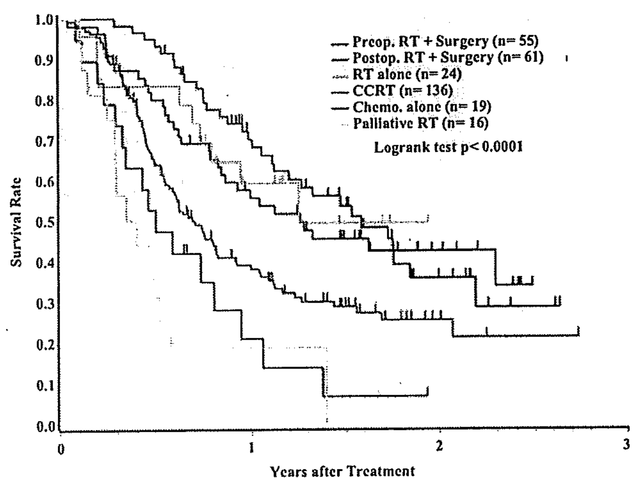
Figure 2 Survival of patients treated by chemotherapy and/ or radiotherapy



	Years after Treatment		
	1	2	3
Preop. RT + Surgery	96.0%	72.0%	72.0%
Postop. RT + Surgery	84.3%	71.9%	–
RT alone	74.5%	63.8%	–
CCRT	78.4%	64.3%	–
Chemo. alone	–	–	–
Palliative RT	66.7%	–	–

Figure 3 Survival of patients treated by chemotherapy and/ or radiotherapy (cStage I-IIA)

Figure 4 Survival of patients treated by chemotherapy and/ or radiotherapy (cStage IIB-IVB)



	Years after Treatment		
	1	2	3
Preop. RT + Surgery	55.6%	35.8%	–
Postop. RT + Surgery	70.1%	42.3%	–
RT alone	59.1%	–	–
CCRT	38.2%	25.5%	21.2%
Chemo. alone	21.1%	–	–
Palliative RT	18.8%	–	–

V. Clinical Results in Patients treated with Esophagectomy in 2000

Table 34) Cases of esophagectomy (treatment, surgical procedure, and location of the tumor)

Treatment	Cases (%)
Esophagectomy	568 (52.4%)
Esophagectomy + radiotherapy*	108 (10.0%)
Esophagectomy + chemoradiotherapy**	186 (17.2%)
Esophagectomy + chemotherapy***	202 (18.7%)
Esophagectomy + endoscopic treatment	19 (1.8%)
Esophagectomy + other treatment	0
Total	1083 (100%)

*: + endoscopic treatment (1 cases)
**: + hyperthermia (9 cases), + endoscopic treatment (2 cases), + other treatment (1 case)
+ other treatment (2 case)
***: + endoscopic treatment (2 cases), + other treatment (1 case)

Surgical procedures	Cases (%)
Esophagectomy without reconstruction	4 (0.4%)
Esophagectomy + reconstruction (2-stage operation)	27 (2.5%)
Esophagectomy with reconstruction	1045 (96.5%)
Unknown	7 (0.6%)
Total	1083 (100%)

Location	Cases (%)
Pharynx	8 (0.3%)
Cervical esophagus	11 (4.3%)
Upper thoracic esophagus	119 (10.0%)
Middle thoracic esophagus	479 (49.6%)
Lower thoracic esophagus	263 (27.0%)
Abdominal esophagus	68 (5.5%)
EG junction	22 (0.8%)
Cardia	4 (0.2%)
Unknown	79 (2.4%)
Total	1083 (100%)

Table 35) Cases of esophagectomy (surgical approach and region of lymphadenectomy)

Approach	Cases (%)
Cervical approach	33 (3.0%)
Right thoracotomy	866 (80.0%)
Left thoracotomy	21 (1.9%)
Left thoracoabdominal approarch	29 (2.7%)
Laparotomy	21 (1.9%)
Transhiatal (without blunt dissection)	3 (0.3%)
Transhiatal (with blunt dissection)	46 (4.2%)
Sternotomy	15 (1.4%)
Others	8 (0.7%)
Unknown	41 (3.8%)
Total	1083 (100%)

Region of lymphadenectomy	Cases (%)
(-)	23 (2.1%)
C	23 (2.1%)
C+UM	11 (1.0%)
C+UM+MLM	4 (0.4%)
C+UM+MLM+A	421 (38.9%)
C+UM+A	3 (0.3%)
C+MLM	0
C+MLM+A	5 (0.5%)
C+A	6 (0.6%)
UM	11 (1.0%)
UM+MLM	14 (1.3%)
UM+MLM+A	323 (29.8%)
UM+A	3 (0.3%)
MLM	14 (1.3%)
MLM+A	115 (10.6%)
A	39 (3.6%)
Unknown	68 (6.3%)
Total	1083 (100%)

C: bilateral cervical nodes
UM: upper mediastinal nodes
MLM: middle-lower mediastinal nodes
A: abdominal nodes